UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

MANAGEMENT PLAN

FOR

THE FISHER BODY WORKING CIRCLE

ONTONAGON COUNTY - MICHIGAN

1935

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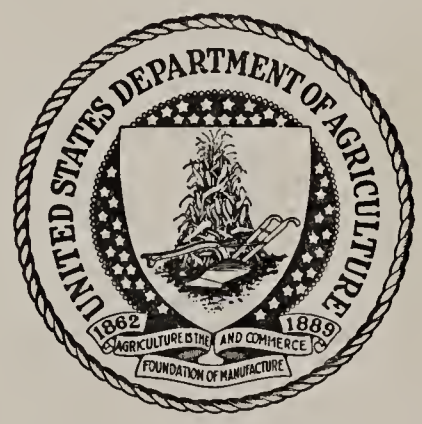

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Forest Code
Northern Hemlock & Hardwood Division
Fisher Body Working Circle

MANAGEMENT PLAN

FOR

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ONTONAGON COUNTY

MICHIGAN

Respectfully submitted:
April 1, 1935.

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Associate Code Examiner.

Approved:

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Forest Code Examiner.

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Regional Forester.

PURPOSE OF THIS STUDY

As set forth in Article I, the purpose of the Lumber Code is, in part, "to conserve forest resources and bring about sustained production thereof." Under Schedule C of the Code, it is agreed that "to the extent practicable partial cutting or selective logging shall be the general standard for local measures of forest practice," and it is also recognized that "the extent to which these undertakings are capable of successfull accomplishment, is dependent upon the extent and character of public cooperation in each state."

To the U. S. Forest Service has been delegated the duty of cooperating with the Conservation Committees of the various divisional agencies in all matters pertaining to conservation of forest resources. The Conservation Committee of the Northern Hemlock and Hardwood Division has as one of its duties the determination, through study, of the opportunities for sustained-yield management by economic units, and the development of plans and the encouragement of their adoption. As advisers to and cooperators with the divisional agency in the Lake States, we have here made a study of such an economic unit for the purposes set forth.

Briefly then, this study has for its objective the determination of the practicability of a sustained-yield operation through selective logging practices in the area of mature timber hereinafter described. The resulting conclusions are based on a careful analysis of the present stand, the growth rate of the residual stand, and the careful determination of the possibility of successive cuts of timber taken from the same areas, taking into consideration, as far as possible, the present required demand for particular species to make possible a sound, economic sawmill operation.

In the body of the report, following, are set forth different plans of ownership, any one of which may be set up as an objective. We believe it is apparent that these ownership plans are practical and fundamentally sound, and that substantial cooperation is extended by the Government as called for in Schedule C of the Lumber Code. The results of this tudy and the conclusions arrived at are likewise basically sound and are commended to the serious consideration of all persons concerned.

I N D E X

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PART I

SUMMARY & CONCLUSIONS

LOCATION: (See map)

This report is based on a logical sized area, or working circle, located in Ontonagon County, Michigan, on the south shore of Lake Superior. For convenience the name "Fisher Body working circle" is used in the body of the report.

AREA and OWNERSHIP: (See map)

The gross area under consideration is 125,000 acres.

The ownership of this area is as follows:

General Motors Corporation (Fisher Body)		35,132 acres
R. Connor Company		6,557 acres
Longyear Estate	38,142 acres)	49,655 acres
Keweenaw Land Company	11,513 acres)	
Nine owners of tracts from 1300 to 5500 acres.		22,434 acres
Fifty owners of tracts from 30 to 900 acres		11,222 acres
TOTAL		125,000 acres

COVER TYPES:

The gross area is divided into different type classifications as follows:

	Acres	Per Cent
Virgin timber	111,150	89
Restocking areas	11,204	9
Not restocking (brush & muskeg)	2,351	2
Unmeandered lakes	295	-

FIRE RISK:

Past records indicate a relatively low fire hazard in this area. Under selective logging, this will not be materially increased and because of more intensive protection afforded by

the Federal government the future risk will be considerably reduced.

RELATIVE COSTS OF SELECTIVE LOGGING:

Based on studies previously made, it is shown here that under average conditions, selective logging costs are no higher than under clear cutting practices. The lower direct costs and the increased value of the lumber produced, more than overcome the increased fixed costs and reduced log and mill over-run.

TOTAL VOLUME OF TIMBER:

The total volume of timber products is estimated to be as follows:

Saw timber (10 inches and up d.b.h.)	1,160,749,000 feet, B.M.
Chemical wood from tops of trees	904,000 cords
Chemical wood from trees under 10 inches d.b.h.	747,000 cords
Hemlock bark	285,000 cords
Hemlock, spruce and balsam pulp wood	86,000 cords
Cedar posts	650,000 pieces

DISTRIBUTION OF VOLUME BY SPECIES:

The distribution of the volume by species over the entire working circle and on that portion of the area now controlled by the General Motors Corporation is given in the following table:

SPECIES COMPOSING PRESENT VOLUME

Species	Fisher Body working circle 125,000 acres Per cent	Fisher Body lands within working circle 35,132 acres Per cent
Sugar maple	37.6	40.2
Hemlock	28.9	25.7
Yellow birch	11.7	11.5
Basswood	7.5	10.7
Red maple	1.9	°
Cedar	2.0	3.4
White spruce	1.4	0.5
Balsam	0.7	0.3
Black and white ash	2.0	2.1
Elm	2.3	2.4
White pine	3.3	1.9
Red oak	0.8	1.3
Tamarack	.0	.03
	Board feet on average acre - 9300	Board feet on average acre - 8002

°Included with sugar maple.
Note: Based on average volumes of all virgin and cut-over lands.

CUTTING DATA CONCLUSIONS:

The detailed study made on this working circle shows the following results:

1. Sixty-six per cent (66%) of the total volume is to be removed in the first cutting cycle.

2. Total annual cut possible of all species combined is 30,400,000 feet, board measure.

3. Total area which can be cut over annually is 4,450 acres.

4. The cutting cycle is placed at 25 years.

5. The rotation is on a basis of 200 years.

6. The predicted allowable cut during the

second cycle is 23,600,000 feet, B.M. This allowable cut will gradually increase after the second cutting cycle until it again reaches approximately 30,000,000 feet per annum.

7. While 66 per cent of the total volume is to be removed during the first cycle, this varies considerably with species. In some species as high as 91 per cent will be removed and in others as low as 46 per cent.

8. The growth per acre per year in the residual stand after selective logging has been determined to be 180 feet, board measure.

DISTRIBUTION OF VOLUME BY SPECIES:

The distribution by species of the allowable cut during the first two cutting cycles is as shown in the tables given below. Attention is called to the increased volume of sugar maple to be removed in the second cutting cycle, which shows the improvement in the stand to be expected through selective logging as set up in this plan.

SPECIES COMPOSING VOLUME TO BE REMOVED

Species	Per cent in First cut	Per cent in Second cut
Sugar maple	32.1	46.8
Hemlock	29.4	26.2
Yellow birch	14.0	6.9
Basswood	9.7	3.1
Red maple	1.3	3.0
Cedar	2.4	2.2
White spruce	1.0	3.3
Balsam	0.5	1.3
Black and white ash	2.0	2.4
Elm	2.4	1.7
White pine	4.0	2.9
Red oak	1.2	.2
	100.0	100.0

PRESENT DEPENDENT POPULATION AND POSSIBILITIES:

The study shows that on the present production schedule there are between 1,000 and 1,100 persons (250 to 260 workers) who can be maintained in woods work. By increasing the production to the allowable cut indicated, this dependent population can be increased by 50 per cent.

The present dependency on the milling, is placed at 1,300 persons. Again by increasing the cut, and by possible closer utilization, this can be increased by 50 per cent to a total of about 1,900.

If this increase takes place it would remove all persons in the area now on relief from the relief rolls and would absorb additional workers not now residing in the territory.

PERMANENT OWNERSHIP RECOMMENDATIONS:

There are three methods of ownership outlined, under which a sustained yield program is feasible (see Pages 19 & 20). The first of these plans, calling for partly private and partly government ownership, is recommended as the most desirable from all viewpoints.

METHODS OF LOGGING:

From the economic, protective and aesthetic viewpoints it is recommended that truck logging be considered as the basis for the transportation of woods products. Ownership of 50 per cent, or more, of the area vested in the Federal government (as under plan number 1 - page 19), will require a system of fire-protection roads which can easily be converted to utilization roads.

If railroad construction is necessary at all it should be confined to one main line, which will be fed by the truck roads.

PART II.

FOUNDATION

INTRODUCTION:

The Fisher Body working circle is pre-eminently suited to continuous production under a selective cutting system. It includes one compact unit, 89 per cent of which contains virgin timber growth. The timber is sufficient to support, in perpetual operation, a sawmill utilizing annually 25 to 30 million feet board measure and employing the heads of 400 families year-long in mill and woods. Four owners control 73 per cent of the area and a proportionate part of the volume. Two of these owners are non-operating and are practically under one controlling head.

1. LOCATION: (See map)

The Fisher Body working circle lies within the Ottawa National Forest. It extends from Lake Gogebic northwest through the Porcupine Mountains to Lake Superior and is about 25 miles east of Iron Mountain, Michigan. The bulk of the area lies within Townships 48 and 49 North, Ranges 43 and 44 West, and Township 51 North, Ranges 42, 43 and 44 West.

2. AREA:

An area of 125,000 acres is included within the boundaries of this working circle. No part of this acreage is now owned by the Federal government. The ownership is divided as follows:

Keweenaw Land Company	-	38,142
Fisher Body Company	-	35,132
Longyear Estate	-	11,513
R. Connor Company	-	6,557
Nine owners of tracts from 1300 to 5500 acres each	-	22,434
Fifty owners of tracts from 30 to 900 acres each	-	11,222
TOTAL	-	125,000 acres

3. TOPOGRAPHY:

The northwest third of the working circle is within the Porcupine Mountains. The relief in the mountains is rugged, and toward the lake shore it is broken by deep gullies. Elevations range from the lake shore to 2,000 feet above lake level. The south two-thirds of the unit is drained by Iron River and its west branch. The area in the Iron River basin is level to rolling except along the streams, which generally flow in deep gullies. A few small wet muskeg-type swamps occur in the north along the Carp and Little Carp drainages.

The soil is typically hardwood-producing. The southeast two-thirds of the unit is within the Ontonagon silt loam and Porcupine loam soil types, and the northwest third includes the rough stony land of the Porcupine Mountains. The area is generally too rugged for extended agricultural development, but is well adapted to the raising of forest products.

4. THE STAND:

A typical mixed northern hemlock and hardwood virgin forest occurs on 93 per cent of the Fisher Body working circle. The types vary from pure hardwood to pure hemlock, with all intermediate gradations. Sugar maple predominates by volume. White pine, cedar, and white spruce types are infrequent. Table No. 1 indicates the acreage of the various timber types.

TABLE No. 1

TYPES AND AGE CLASSES°

Type	Diameter group	Acres
Hardwoods	15" and over	55,100
Hardwoods	10" to 15"	12,100
Swamp hardwoods	15" and over	2,659
Swamp hardwoods	10" to 15"	886
TOTAL		70,745
Mixed hardwoods and hemlock	15" and over	27,720
Mixed hardwoods and hemlock	10" to 15"	2,360
Mixed hardwoods & hemlock (swamp)	15" and over	295
TOTAL		30,375
Hemlock	15" and over	5,900
Spruce-balsam	15" and over	295
Spruce-balsam	10" to 15"	1,770
White pine	15" and over	1,180
Cedar	15" and over	590
Cedar	10" to 15"	295
TOTAL		10,030
TOTAL virgin types		111,150
Hardwoods	5" to 9"	3,832
Hardwoods	2" to 4"	2,360
Aspen	5" to 9"	3,832
Aspen	2" to 4"	1,180
TOTAL		11,204
Non-productive brush and muskeg		2,351
Unmeandered lake and stream		295
TOTAL		2,646
TOTAL area		125,000 (acres)

°Hardwood type:- Any stand wherein 80 per cent or more of volume is hardwood.
Hemlock type:- Any stand wherein 80 per cent or more of volume is hemlock.
Mixed hardwood & hemlock type:- Any stand of mixed hardwood and hemlock not falling in either of above classification.

TABLE No. 2

VOLUME OF SAW TIMBER BY MAJOR TIMBER TYPES

	Virgin timber types			Hardwood saplings and poles	Total
	Hardwoods M.ft.B.M.	Hardwood & Hemlock M.ft.B.M.	Hemlock M.ft.B.M.	M.ft.B.M.	M.ft.B.M.
Sugar maple	364,322	72,200	3,060	3,910	443,492
Hemlock	58,100	184,380	85,856	2,202	330,538
Yellow birch	88,800	37,900	4,600	743	132,043
Basswood	65,700	18,700		179	84,579
Red maple	10,900	7,800	1,910	700	21,310
Cedar	8,000	5,450	8,660		22,110
White spruce	11,700	4,580	2,950	278	19,508
Balsam	4,570	1,680	1,980	545	8,775
Black and white ash	16,600	5,300	940		22,840
Elm	24,000	2,080	364		26,444
White pine	20,100	16,000	3,180		39,280
Red oak	8,100	1,730			9,830
TOTAL	680,892	357,800	113,500	8,557	1,160,749

Note: These volumes by types are adjusted to harmonize with the average total volume on all types, as shown on Stand Table No. 1-A.

VOLUMES PER ACRE INCLUDING ALL SPECIES

	Feet, board measure
Hardwood type	9,814
Hardwood-hemlock type	12,039
Hemlock type	11,554
Hardwood saplings and poles (cut-over land)	1,383
Average for all virgin types	10,356
Average for alltypes on 125,000 acres	9,300

5. GROWTH IN THE VIRGIN STAND: (See Table No. 1)

A study of the rate of growth on more than 1,200 trees mechanically selected over the entire Fisher Body working circle indicates a gross growth of 244 board feet per acre per year on sound trees of all species. The timber stand is a typical virgin forest, having all age and size classes represented. The highest net growth is concentrated in the young trees of the stand. The deterioration through windfall and decay is concentrated in the larger diameters. The two counter-balance each other. That the stand is in equilibrium is illustrated in the following table, adopted from a report on virgin timber types by Mason and Stevens, and adjusted to harmonize with the gross growth rate herein given.

TABLE No. 3

GROWTH AND DETERIORATION

Diameter, breast high	Growth per acre per year in feet, board measure		Deterioration per acre per year in feet, board measure	Gross growth by diameter classes, in per cent
	Net	Gross		
	(1)	(2)	(3)	(4)
11	11	11	0	4.50
13	35	38	3	15.50
15	34	45	11	18.30
17	21	37	16	14.80
19	4	33	29	13.45
21	-10	27	37	11.05
23	-21	20	41	8.15
25	-20	15	35	6.15
27	-19	7	26	2.80
29	-16	5	21	1.82
31	-13	3	16	1.26
33	- 4	2	6	2.43
35	- 2	1	3	
TOTAL	0	244	244	100.21

Columns No. 4 in Tables No. 3 and 5, are worthy of further comment. Sixty-seven per cent of the total growth in virgin stands occurs in trees 20 inches and under. After the removal of 66 per cent of the volume, 94 per cent of the growth is concentrated in these same diameter classes. In other words, the cut has removed those trees which are adding to the stand the least growth, or 26 trees per average acre, and has left those smaller diameters producing the greatest growth, or 53 trees per average acre.

On the Fisher Body working circle the average tree on the average acre adds one inch in diameter in ten years. The growth rate by species is given in Table No. 4.

TABLE No. 4

DIAMETER GROWTH OF TREES IN VIRGIN STANDS

Species	Years required to grow one inch in diameter.
Sugar maple	9.9
Hemlock	10.7
Yellow birch	10.6
Basswood	10.6
Red maple	9.4
Cedar	12.3
White spruce	6.3
Balsam	9.7
Black and white ash	9.5
Elm	10.4
White pine	7.5
Red oak	7.7
Weighted average	10.0

6. GROWTH IN THE RESIDUAL STAND: (See Table No. 2-A)

In the sampling done to construct Stand Table No. 1-A, which shows the distribution of species by diameter classes on the average acre of virgin timber, a record was kept to show those trees which, because of their size and condition, should be removed in the first cutting operation, separately from those thrifty smaller diameter

trees, which should be retained for future cuts. This residual stand, based on the growth of trees in the virgin stand as measured, is producing on the 53 trees per acre left, 116 board feet per acre per year. It has been found elsewhere that losses in residual stands characteristic of this working circle, run about 11 per cent. Applying this reduction, the recommended residual stand is now growing at the rate of 103 board feet per acre per year net, but conditions after selective cutting are such that the increment is materially increased. This increase, or response in growth caused by reducing the number of trees competing for soil and light space, approximates 80 per cent of the net growth in the residual stand added to the present growth, or a total growth of 180 board feet per acre per year. This rate of growth is used to determine future volumes in the residual stand, and the resultant cutting cycle.

TABLE No. 5

VOLUME GROWTH PER ACRE ON RESIDUAL STAND

Diameter, breast high	Growth per acre, per year, feet board measure	Growth by diameter classes, per cent
	(2)	(4)
11	7.0	6.1
13	35.0	30.5
15	29.0	25.3
17	24.0	20.9
19	13.0	11.3
21	5.0	4.3
23	1.5	1.3
25	.5	0.5
27	.5	0.4
29	Negligible	0.2
TOTAL	116	100.8
11 per cent deducted for cull	103	
80 per cent added for increase in the growth rate after cutting	180	

These volume growth rates are conservative. They are based on the ten inch and over trees in the recommended residual stand. Trees of smaller diameter are constantly growing into the stand, increasing the growth rate. It is safe to assume that in the heavy (66 per cent by volume) cut set-up, the trees growing into the commercial size classes in the residual stand will add a greater volume to the stand than will be lost in trees already of commercial size, by the slight crowding effect of these new entrants. The growth rate of 180 board feet per acre per year on the residual stand, will result in a volume 25 years hence of 8,000 feet board measure per acre, provided careful timber marking and felling is done in the first cut.

7. HISTORY OF FIRE AND LOGGING:

(a) Fire History. From available records and from actual study on the ground, it is apparent that fires in the past have not been of serious consequence in this particular area. This condition is undoubtedly due to the heavy stands of virgin hardwood timber, which are as fire-proof as any timber type, as well as by the inaccessibility of the area as a whole to the general public, and the normally heavy precipitation.

The general low hazard is brought out in the following tabulation:

TABLE No. 6

TABULAR STATEMENT OF FIRE HISTORY

Period burned over (years)	Total acres burned	No.acres burned clean	No.acres burned moderately	Per cent of area stocking to aspen	Per cent of area stocking to hardwoods	Remarks
1920-1934	6,144	4,680	1,464	62	38	Two or more fires over clean-burned area.
1910-1920	4,386	525	3,861		100	Poor commercial hardwood left on most of this area.
1900	1,170	1,170		100	90	Fine hardwoods under aspen poles.
TOTAL	11,700	6,375	5,325			
Average acres per year	334	182	152			

Roughly, one-third of clean-burned area was cut over before being fire swept.

The above table indicates that over a period of 35 years or more only one-fourth of one per cent of the area has been burned annually. When it is realized that most of the fires came into the area from outside slashings and that little or no protection was given this area prior to 1925, the record speaks for itself.

Under selective logging such as is recommended in this report, the fire hazard is increased to only a moderate degree. Having recently been brought into the confines of the National Forest, the protection system as set up by the U. S. Forest Service will soon be available. This system will be on the usual intensive basis and will more than counteract the increased hazard due to logging. It can be safely said, that the fire hazard will be smaller in the future than it has been in the past; and under these conditions, fire hazard should not be considered a barrier to the practice of sustained yield forest management.

It is interesting to note here that those areas burned in the years 1910 to 1934 have reproduced themselves largely with aspen and that these areas generally have an incomplete stand of the more valuable hardwood in the under story. However, in those areas which were burned 30 or more years ago, it is noted that a stand of young hardwood is now coming up under the aspen. Apparently as soon as there is sufficient forest cover to allow the germination of hardwood seed from nearby adjacent unburned stands, it becomes established and produces a more or less fully stocked stand of hardwoods. The time required for this step in the conversion of forest types after a fire is, as indicated, from 30 to 40 years. Repeated fires and large areas of burn may not fully re-stock to hardwoods until one or more crops of aspen are removed.

(b) Logging History: Over the area as a whole, very little logging has been done, as is shown in Table No. 7. A small amount of timber, mostly white pine, was removed in areas near the mines, and where the pine was so removed there remains an almost complete stand of commercial hardwood. This white pine was cut about 30 years ago. Only 2,400 acres of the entire area studied have been cut clean. Therefore, we have to deal with as near a virgin stand of timber as is left in the Lake States, and cut-over areas make up a very small portion of the working circle.

TABLE No. 7

TABULAR STATEMENT OF LOGGING HISTORY

(Area cut over and later burned not included)

Period cut over (years)	Acres cut over	Acres heavily cut	Acres on which white pine only was cut	Remarks
0-10	590	590		
11-20	880	880		
21-30	4,980	900 (18%)	4,080 (82%)	Much of this was cut so lightly that the residual stand is a hardwood, saw-log stand.
TOTAL	6,450	2,370	4,080	

8. ECONOMIC SITUATION:

(a) Towns and communities and their relation to the area: One of the principal present-day objectives of a sustained-yield operation is the maintenance of established communities through a sustained industry, resulting in sustained payrolls, agricultural markets, freight tonnage, and all other necessary community activities. The day of people moving to new frontiers in their search of employment in wood-using industries is definitely in the past. In the earlier days of the lumber industry, the mills, camps, and virtually the entire dependent communities were able to move on to new stands of virgin timber, where all of the activities of employment and general business could be resumed, often on an enlarged scale. True, the abandoned areas became problems in many ways, but of employment there was usually plenty. Today, and without doubt in the future, we are faced with the additional problem of maintaining employment in the areas affected; or, as an alternative, of increasing the relief rolls and expanding the morale-destroying dole system.

It is interesting, therefore, to dwell upon the economic and social aspects of this particular area and the possibilities of gainful employment in the wood-conversion industry.

In the area under consideration there are at present no towns or settlements. Immediately adjacent, however, are the settlements of White Pine and Bergland. The townships of Carp Lake and Bergland, which are included within this area, have a total population of 1,100 people, of whom approximately 200 are dependent on farming. In addition, seasonal employment and income is given through recreational busines. However, at present, figures indicate that practically 100 per cent of the population of Carp Lake township and about 40 percent of Bergland township are on direct relief.

The logging for the company as now being carried on north and west of Ironwood, is giving employment to from 250 to 260 men. Using a figure of four to a family, it can be seen that under perpetual yield this work alone at the present rate of production will maintain, at a living wage, the present population for an indefinite period. However, our study indicates a possible removal 50 per cent greater than the present annual cut which should then likewise increase the present dependent population. Again, closer utilization, through the sale of cull material to the Ontonagon Fibre Company, additional cutting of pulpwood, and the possibilities of the erection of a wood distillation plant and a flooring plant, for which there is ample raw material, makes the prediction possible that this area under continuous production can profitably support a population from two to two and one-half times as large as at present in woods work alone.

The two sawmills now used in converting the products of the forest are employing approximately 325 workers which, according to our figures, means the maintenance of some 1,300 people. The total population of the townships of Interior and McMillan, in which these two sawmills are located, is at present 2,125. Thus, under the present production schedule 61 per cent of the population is directly dependent upon these two conversion plants. By increasing the cut from the present average of 20 million to an allowable cut under sustained yield of 30 million, it is conceivable that an increase of more than 50 per cent in the population could be directly sustained by the operations. If closer utilization, as is mentioned above, can be brought into the picture the present population could, it would seem, be easily doubled for an indefinite period.

The Ewen and Trout Creek mills, to which this timber will be transported, are not located conveniently. The ideal organization would result from the construction of a mill of capacity sufficient to handle the maximum allowable cut under continuous production forest management, in the timber center of the working circle. This would reduce the freight bill and

hauling costs, encourage and make practicalbe the use of lower grade forest products, and cause to be developed a permanent forest community close to the job. Although no study has been made to show the increased logging cost due to the long haul to the manufacturing point, that increase very clearly exists. This loss would perhaps not be made up during the first cutting cycle if the mill were moved now, but under the recommended continuous cut plan a saving would ultimately be made.

It must be realized that the above figures on employment will depend, to a large extent, upon general market conditions. What we show here are simply the possibilities of continuing or sustained communities as against vanishing or "ghost towns" based upon the perpetual supply of timber from this particular area under continuous yield management. Table No. 8 shows concisely the possibilities of permanent employment in the woods and in the mill, not taking into consideration closer utilization than is at present practiced. The figures in Column No. 5 showing the population indirectly supported, refer to such outside activities as doctors, teachers, storekeepers, gasoline station attendants, etc., and is arbitrarily figured at 10 per cent of the directly dependent population.

TABLE No. 8

POPULATION STATISTICS

Political subdivision	Present population	Per cent of population on relief	Possible population which can be permanently supported under allowable cut	Population added for indirect support	Total
Woods area Carp Lake & Bergland Townships	1,100	61	1,650	165	1,815
McMillan and Interior Townships	2,125	15	1,900	190	2,090

Note: By closer utilization, the total permanent population could be further increased, the increase depending upon the degree of utilization.

(b) Recreation: The Fisher Body working circle, particularly that portion in the Porcupine Mountains, where the company's holdings are concentrated, has a high potential value for recreation. There are a few interior lakes, numerous trout streams, and the attractive shore line of Lake Superior, in addition to the large block of virgin timber, and wilderness conditions, all of which attract tourists to the region. The proposal to selectively log the area, reducing the cut adjacent to lakes and roads, will effectively preserve all recreational advantages. Coincident with the reduced cut on areas of recreational value, will be the reduction in fire hazard occurring with reduced slash and greater shade over the ground. Areas, therefore, which will ultimately receive the heaviest use by recreationalists will also be subject to the least fire hazard.

Selective cutting on the area in general will leave 53 trees out of the total stand of 79 over ten inches in diameter on the average acre. This change in cover and disturbance of wilderness conditions will not be observed by the average recreationalist, particularly 5 to 10 years after the cut is made.

(c) Ownership: There are sixty land owners within the working circle as delineated, the acreage in individual cases varying from 30 to 38,000. The larger operating owners are the General Motors Corporation, the R. Connor Lumber Company, and the Bonifas Lumber Company, which companies control 43,517 acres. Major non-operating owners are the Keweenaw Land Company, and the Longyear Estate, controlling 49,655 acres. Thus 75 per cent of the area in question is owned or controlled by five companies, two of which are under one administrator.

General Motors land and timber are concentrated in the north one-third of the area and in alternate sections throughout the southwest portions. Keweenaw Land and the Longyear Estate ownerships are largely represented by alternate sections in the south two-thirds of the area. These two ownerships represent 67 per cent of the acreage involved.

The feasibility of a sustained yield management plan is to a large extent dependent upon an available supply of timber, large enough to maintain a profitable production schedule in the conversion end of the operation, and still be able to leave sufficient trees of merchantable size on the ground, so as to insure a perpetual forest. Basing our estimates of the amount of timber needed on present production schedules of the company, it becomes apparent that there is no one owner with sufficient acreage to practice sustained yield forestry. On individual ownerships sustained yield can only be placed in effect by drastically reducing the current annual production. It is considered

that this is impracticable at the present time. For this reason we are basing this report upon all of the available timber within the working circle of 125,000 acres. If at any time a reduced production is called for, the working circle could be so adjusted as to fit prevailing conditions.

As stated above, the company now owns or controls 35,132 acres of virgin timber within this working circle. There are three plans by which all of this timber can be selectively logged and placed under sustained yield management, as follows:

1. The company to retain ownership in all land and timber now under its control. In addition, exchanges on an equitable basis to be effected with the R. Connor Company for 6,557 acres owned by them and with the Bonifas Lumber Company for the 2,880 acres now owned by that company within the working circle. This will bring the total ownership of the company up to 43,517 acres.

   Assuming that additional purchases by the company are not desirable, the Federal government, through the United States Forest Service, will purchase the land and timber from the non-operating owners, so as to effectively block up the working circle. Basing its decision upon the actual application of sustained-yield management, the Forest Service will then consider the entire block of timber as one unit, to be cut in accordance with the plan set forth in this report, and all government-owned timber will be available for purchase at current market prices. This, in effect, is placing the Federal government in a position to supply more than 50 per cent of the timber necessary for a sustained-yield operation. It is apparent that this is a marked degree of governmental cooperation, as called for in Schedule C of the Lumber Code, in return for practice of sustained-yield forestry on the privately-owned lands.

   From all viewpoints this plan number one is earnestly recommended for the serious consideration of all concerned. It not only assures proper forest practices, but in addition is an encouragement of continuing private initiative in the lumber business of the region.

2. The second plan in order of desirability will call for the cutting of the company's timber, in accordance with the plan outlined in this report, with the purchase by the Federal government of all land and residual timber. Under this plan the company would operate under a timber reservation over a period of time sufficiently long to allow of the removal of the 66 per cent of the timber to be cut.

This procedure will call for the marking by the Forest Service of all timber to be cut, with payment to be made to the company for all residual timber. This plan will mean that eventually all ownership within the area will be vested in the government, and will further mean the entire removal of private investment and initiative. The sustained yield management will be affected and the degree of governmental cooperation called for in Schedule C of the Lumber Code will be materially increased. It is not deemed as desirable from the public viewpoint as is plan number one.

3. If neither plan number one nor two is considered applicable, then it is in the public interest for the government to purchase all of the land and timber within the working circle, so as to insure a sustained yield management. Under this plan the government will be going to the last extreme, rather than cooperating to secure proper forest management. It is not thought that the industry had this extreme in mind when government cooperation was asked for in Schedule C of the Code, and this plan will not, therefore, be in accordance with the spirit or letter of the Lumber Code.

It is recognized that the company's ownership of timber rights only on some 13,973 acres of land complicates the picture to some extent. Satisfactory arrangements on this acreage will have to be worked out at a later date. In no event must this acreage be excluded from sustained yield management.

(d) Scattered Company Ownership: No report in detail is being made upon the acreage owned by the company outside of this working circle. By and large this acreage should be included in other working circles to be laid out. It is recommended, therefore, that all company-owned timber outside of this working circle (comprising some 20,000 acres), be purchased outright by the United States Forest Service, so that it may be included in other working circles under sustained yield management.

(e) Tax Situation: Using figures on 3,800 acres of company timber, well distributed throughout Township 48 North, Range 47 West, we find that the average value for tax assessment purposes is $33.70 per acre. The average annual tax on this land and timber is at present 50½ cents per acre. These figures are taken from information furnished by the company and indicate that the 15-mill limitation provided by Michigan law is in practical effect in this territory.

Under selective logging, such as is outlined in this report, there will be left on the ground approximately 1/3 of the commercially valuable timber. By and large, this remaining timber will be in the smaller diameter classes, and therefore, will probably be looked upon by the assessor as being less valuable per thousand feet than the original stand. It is reasonable to assume, therefore, that as fast as any certain description is logged under the plan here set forth, the assessment will drop to approximately 25 to 30 per cent of the original, $33.70 per acre, or to an average figure of not to exceed $10 per acre. Taxes at the 15-mill rate would then be 15 cents per acre per year until a larger volume of commercial timber, through growth, is in evidence. Based on a cutting cycle of 25 years and a volume at the end of that time of 8,000 feet per acre, the valuation 25 years hence would be approximately $30. Averaged for the 25-year period, the value would be approximately $20 per acre, or a tax of 30 cents per acre per year.

The forest tax law, known as the Pearson Act, permits the listing of selectively cut lands and advanced second growth upon the approval of the Michigan State Conservation Commission. Such lands are subject to a specific tax of 10 cents per acre per year plus a yield tax of 10 per cent of the stumpage value at the time of harvest. Assuming the cutting cycle of 25 years, with a second cut of say 5,250 feet per acre, the average annual tax under the Pearson Act will probably be the specific tax of 10 cents plus another 10 to 12 cents for the yield tax, or a total of from 20 to 22 cents per acre.

The above rough calculations indicate that the lower tax cost would occur under the so-called Pearson Act. It is realized, however, that prediction of future taxes may be futile, and this is indicated at present by the fact that there is a bill before the present legislature to reduce the tax per acre under the Pearson Act to three cents annually, with a corresponding reduction in the yield tax. We prefer, therefore, not to predict future taxes; but under either of the two plans of taxation mentioned above, it is readily apparent that the average annual tax per acre on property is gradually being reduced. It is our thought that this trend will continue to the point where the

property tax will not be of any great importance when methods of logging are being considered.

Some consideration should probably be given to the Federal income tax. We have been given to understand that it is not too difficult to justify an allocation of the greater part of the stumpage value to the material of larger sizes or that which is cut, thus considerably increasing the unit stumpage value for depletion purposes. The total depletion allowance would, of course, be unchanged, but the financial advantage of realizing on it at a more rapid rate is obvious. We believe that this matter will stand investigation.

(f) Production Costs and Timber Values. Selective vs. Clear Cutting: The relation of production costs and lumber values per M in clear-cut logging and selective cutting is based on previous forest research work modified to fit the stand under discussion as summarized in the following discussion. Supporting tables are given in the appendix on pages 55 to 61. The clear cut operation is based on stand table No. 1-A and the selective cut on stand table No. 2-A.

Present logging costs were approximated to be $8.10 and milling costs $9.70 per M. Where variations from these costs occur in actual practice, proportionate changes will also occur in the net profits under the selective vs. clear-cut methods.

Mill-run lumber values per M were set at $21.00 for hemlock, $31.00 for sugar maple, $32.00 for yellow birch, and $30.00 for other hardwood species. Variations in these will also change the statement as to profits.

A cut of 66 per cent of the volume under the plan removes 69 per cent of the value from the average acre.

When all trees 10 inches and over are cut in clear-cut logging, the cost of skidding, hauling, felling, bucking, loading, and unloading is 54 cents per thousand more than when the recommended selection cut is made. This is due to handling a greater number of small logs when clear cutting.

The cost of milling logs taken from a clear-cut area is 16 cents per M more than under the run of logs taken from the selective cut recommended in this report. The over run in small logs is not so great in selective logging as in clear cutting, but regardless of this fact there is a net saving in milling costs. This is due to the larger size of the average log handled from the selective cut area.

The percentage of high grades in lumber increases with the size of the average log handled. This increases the value of the lumber per M cut from the selectively handled area $1.19 over the value per M obtained from logs on the clear-cut area.

The positive benefits, therefore, in the recommended selective cut include: a 54 cent per M reduced direct logging cost, a 16 cent per M reduced milling cost, and a $1.19 per M increased lumber value.

While the direct logging costs are decreased under selective cutting, the total logging costs are increased because of the distribution of the constant costs, including railroad, logging road, and camp construction, woods supervision, general expense, taxes and insurance on logs, over a smaller volume cut per acre. This increased cost per M amounts to $1.52.

The difference between the positive and negative values as enumerated is $0.37 per M, which represents the increased return of selective logging over clear cutting. A brief comparative statement may be made, as follows:

	Clear cutting	Selective cutting	Saving	Loss
Direct cost of logging per M	$ 8.10	$ 7.56	$0.54	
Total cost of milling per M	9.70	9.54	.16	
Fixed cost of logging	2.95	4.47		1.52
TOTAL production cost	20.75	21.57	.70	1.52
Value of lumber per M on average acre	29.41	30.60	1.19	
	$ 8.66	$ 9.03		
TOTAL saving and loss			$1.89	$1.52
Increased return under selective logging	.37			.37
	$ 9.03	$ 9.03	$1.89	$1.89

No allowance in the previous discussion was made for stumpage and interest on the invested capital.

In the recommended selective cut, after all major costs are covered and operating expenses paid, a balance of $9.54 per M remains. This sum must cover the stumpage value, the interest on invested capital, and the allowance for profit and risk.

Clear cutting reduces this margin to $8.66 per M.

This discussion has not allowed for the decreased interest on those permanent improvements which, under selective logging, will be used continuously throughout the entire rotation, but which under clear cutting are charged off against one cut in the rotation. This decreased interest further increases the margin for profit in selective logging. It is also realized that the mill overrun varies with the proportion of lumber, timbers, ties or dimension stock sawed. The proportion of lumber grades will vary in the first and second cut. The first cut is a salvage proposition and cull reduces the volume in the higher grades. In addition to the increased value, due to a greater percentage of high grades in the second and subsequent cutting cycles, an increase in the percentage of higher value species will also occur if the proposed selective cut is carried out without variation for present economic demands.

"In general it may be said that selective logging reduces direct logging costs and increases grades, raises the holding, exchange or sale value of the land; makes possible continuous operation and prosperous communities, and protects and increases watershed values." °

° From an Annotted Bibliography of Selective Logging, compiled by United States Forest Service.

PART III.

THE MANAGEMENT PLAN

1. GENERAL OBJECTIVES:

1. To establish a permanent timber business, centered about the Fisher Body holdings, and the Trout Creek and Ewen Mills and communities.

2. To insure a continuous production of saw-timber products.

3. To improve the virgin stands by removing the decadent trees, assuring a net growth almost the equivalent of the gross, thus eliminating the economic waste now prevalent in virgin stands.

4. To assure a more efficient protection of the area.

5. To maintain recreational and scenic values in the well-known Gogebic, Porcupine Mountain, and south shore Lake Superior Regions in Upper Michigan.

6. To preserve an adequate cover for the numerous trout streams in the working circle, and for the game.

7. To develop a closer utilization of forest products in low grades and small sizes.

8. To maintain a permanent forest transportation system.

2. SILVICULTURAL OBJECTIVE:

Direct all cutting toward the removal of over-mature, decadent, diseased, and insect-damaged trees. Reduce the proportion of inferior species in the stand as rapidly as present market demands permit.

3. DESCRIPTION OF THE NORTHERN MIXED HARDWOOD FOREST:

The northern mixed hardwood forest comprises three main timber types: the practically pure hardwood stand; the stand including, roughly, equal parts of hardwood and hemlock; and the pure hemlock stand.

It should be understood that the volumes per acre mentioned in the following type descriptions are for timbered areas only, and are thus much higher than estimates as made by the company which give the volumes by legal descriptions, regardless of the area timbered within the description.

On the working circle the hardwood stand contains an average merchantable volume of 9800 feet, board measure, per acre. Mason and Stevens, in a report to the Von Platen-Fox Company, describes the virgin hardwood type as follows:

> "This timber is a typical all-aged forest, with the various age and diameter classes present in a remarkably orderly manner. In order to understand the treatment which will be recommended, it is necessary to have in mind the way in which nature maintains such a stand in a moderately healthy condition.
>
> The maximum age of the trees is from 300 to 400 years. The most frequent cause of death is windfall, although this may be the result of previous decay which has for many years progressively weakened the mechanical strength of the tree. When a large tree falls, the gap which is left in the crown cover admits light to the neighboring trees, and to the ground, previously densely shaded. There are two results, (a) the establishment of a small dense clump of seedlings in the openings, and (b) an increase in the growth rate of the neighboring trees. As the seedlings of the clump grow, they compete with each other for the limited quantity of light available. The strongest survive, and the others are at the mercy of the larger and taller trees around them, which gradually expand their crowns until they close up the opening left by the fallen tree. The continued existence of any of the clumps, therefore, is dependent on the death of another large tree; and if this occurs soon enough, a new period of relatively abundant light will cause those which have survived thus far to grow more rapidly. Any tree which finally reaches maturity will have passed through a succession of alternations between rapid and slow growth, and will be the survivor of a long, hard struggle.
>
> While individual acres of such a forest may be in a period of stagnation or of relatively rapid growth, the forest as a whole is in a state of equilibrium. If large areas are considered, the loss through decay and windfall is offset by the gain through growth. If the forest were to be recruised ten or twenty years hence there should be no appreciable change found in the volume present."

The mixed hardwood-hemlock type contains 12,000 feet, board measure, per acre of all species. The mixture of species results in a closer utilization of the soil and a greater net volume per acre than normally occurs on pure types. The type is also an all-aged one, but with a deficit in hemlock in the 18 to 22 inch diameter classes and a scattering of large hemlock which are gradually dying out and making way for the sugar maple under story.

The pure hemlock type contains 11,500 feet board measure per acre and includes roughly 80 per cent hemlock by volume. This type has a tendency toward an even-aged condition in groups. It is not the typical all-aged forest of the hardwood type.

A small percentage of the area is stocked to white pine, highland spruce-balsam, and cedar stands.

Hardwood and mixed hardwood-hemlock types on low swamp-like soils occupy 3,840 acres. These stands are commonly inferior to highland types, averaging a lower volume per acre and heavier cull.

The density of stocking in commercial size trees on virgin types is demonstrated by the tabulation given below:

DENSITY OF STOCKING BY TYPES

Type	Below average per cent	Average per cent	Above average per cent	Total per cent
Mixed hardwood	45	41	14	100
Hardwood-hemlock	24	43	33	100
Hemlock	29	28	43	100
Spruce-balsam	57	43	0	100
All virgin types	42	39	19	100

Hemlock types are most likely to be overstocked, hardwoods least likely. The different degrees of stocking are not concentrated on any particular area, but are scattered over the working circle. Average stocking may be considered as the board foot volume, per acre, given in the previous discussion for the hardwood, mixed hardwood and hemlock, and the hemlock types.

The cut-over hardwood types support only 1380 feet board measure per acre, much of which is inferior species for which no market occurred at the time of logging. The young growth and the understocking of reproduction in the virgin stands are predominantly

sugar maple. Basswood sprouts occur about the stumps of older trees. Yellow birch and elm enter the more open spots caused by the death of large trees in the stand. Hemlock is not re-stocking on any type as satisfactorily as are other species. Reproduction of this species is notably lacking.

4. MARKING PRACTICE: (See Appendix, Page 67)

Selective cutting requires that the standing trees to be cut are marked by both a stump blaze and a blaze breast high. The breast-high blaze will guide the cutter, and the stump blaze will indicate to the woods foreman that the cutting was authorized. The stump blaze is in effect a receipt for the tree cut. Trees cut, though not marked, except those in roads or on skidways, are cut in disregard of the marking rules, and cutters must be penalized for such violations. Marking jobs of excellence are sometimes ruined by poor supervision of the cutters. No green trees should be blazed, except those to be cut. Witness trees should be cut high to preserve their identification.

Marking to a fixed diameter limit is not recommended. The record of trees to be cut and left was made from an actual tally on sample plots mechanically spaced over the entire 125,000 acres within the working circle (see map of timber types in appendix). The trees cut are those which should be removed because of defect or poor crown, because of having reached maturity, or in order to open up and regenerate the residual stand. Those left are the most thrifty trees of desirable species, mainly concentrated in the lower diameter classes. Theoretically, the stand left contains the fastest growing trees which will produce the maximum cut of the most desired species in the least time. The trees cut are those containing cull, and those of large diameter which cause an annual reduction in the net increment in the stand. The objective to strive for is a net volume increment in the residual stand equal to the gross, during the second and subsequent 25-year periods, or cutting cycles.

It is generally recognized that cutting to a fixed diameter limit is poor silviculture. In any stand, particularly one of virgin timber, trees in all commercial diameter classes may have poor crowns, resulting in poor growth, or may have rot or crook which will require their early removal on a cutting operation as a stand improvement measure before they become complete culls. Diameters to which trees are cut also vary with the demand for certain species or sizes, and when logging is modified for these practical or economic reasons with due

consideration for the silvicultural requirements of the timber type, no harm ensues. Such changes in diameters to which trees are cut to fulfill the practical requirement of the moment, although not changing the gross volume and even canopy required silviculturally in the residual stand, generally reduce the volume of the choice or desired species in subsequent cuts on the same area. However, the experience of the past in logging history shows that it is the tendency of the despised species of today to become the prized one of tomorrow, and so long as a volume of thrifty fast growing, well-spaced trees, regardless of species but sufficient to produce the desired volume for subsequent continuous cuts, is left on ground, the primary objective of selective cutting and continuous forest production is secure. Where such a substitution of species is not possible, due to the purity of the type, the percentage of cut must be adhered to even though the species is highly desired in the first cut.

It has been clearly demonstrated that selective logging may prove to be a curse instead of a blessing if it is invoked to justify "creaming" or "high grading" of the most profitable areas, species, trees or logs without regard to the effect this may have on the forest.

The marking rules which will bring about sound selective logging are as follows:

1. Mark to flexible diameter limits as given by species:

Sugar maple--ash	17 to 20 inches
Hemlock and spruce	19 to 20 inches
Yellow birch-basswood	18 to 19 inches
Red maple	16 to 17 inches
White pine, elm & red oak	20 to 25 inches
Balsam and cedar	13 to 15 inches

The range in diameters given cover conditions in different timber types. In general, the diameter limit raises as the type becomes more pure or, in other words, as the volume of any one species approaches the total volume on the area.

2. On the entire area all, the cut to be made equals 66 per cent of the total volume per acre. The marking will be guided by this percentage but the quantity actually cut from any one forty and in any one season may vary above or below this percentage.

3. Mark trees under the flexible diameter limits when defective, though now valuable for logs.

4. In younger thrifty stands of pole-size trees, car stakes may be cut to thin the stand. Only the poorer trees should be removed. Leave crop trees for future saw log cuttings. Thinnings in young, unmerchantable stands are not recommended if car stakes are not needed.

5. Leave occasional sound trees over the flexible diameter limits set up where their removal would cause large crown openings.

6. Leave sound trees over the flexible diameter limits when to cut them would cause excessive breakage in smaller trees to be left.

7. Reduce the percentage of cut along swamp edges and on exposed ridges to decrease danger from windfall. Sound trees above the flexible diameter limit should be left to effect this condition.

8. Reduce the cut around lakes and along highways to 50 per cent of the total volume. This will raise the average diameter limit for all species to approximately 22 inches and preserve scenic effects.

9. The volume to be cut on the average acre includes that volume removed from logging roads and skidways, an amount estimated to be 10 per cent of the total cut. In marking, this cut from logging roads must be made up on the cutting area by leaving a few of the most thrifty trees above the flexible diameter set-up.

10. Reduce the cut along the main line logging railroad for a distance of two hundred feet on each side. The shaded area and reduced slash will decrease the fire hazard.

11. Vary the marking. The Stand Tables 1-A, 5-A and 7-A in the appendix show the different proportion of species and diameter classes in the three major types and illustrate the fact that marking must vary with the type changes. The following table summarizes this difference between types from the standpoint of the timber to be cut, and clearly shows that mechanical, fixed diameter marking rules cannot be developed in practicing good silviculture.

TABLE No. 9

COMPARISON OF ALLOWABLE CUT BY TIMBER TYPES
VIRGIN TIMBER

Species	Allowable cut per acre						Allowable cut all types	
	Mixed hardwoods volume	per cent	Hardwood-Hemlock volume	per cent	Hemlock volume	per cent	volume	per cent
Sugar maple	3,034	57	1,375	57	117	38	2,184	57
Hemlock	345	40	4,399	71	5,820	66	2,013	67
Yellow birch	974	76	997	78	291	62	960	79
Basswood	795	84	461	74	0	0	665	85
Red maple	72	46	124	47	104	54	91	47
Cedar	65	56	151	83	654	74	165	79
White spruce	46	27	97	63	35	12	68	46
Balsam	37	56	32	57	92	46	41	56
Black and white ash	149	62	131	74	38	40	139	66
Elm	145	42	43	61	31	84	166	68
White pine	280	96	430	80	204	63	271	77
Red oak	107	91	48	83	0	0	82	91
TOTAL	6,049	62	8,288	69	7,386	64	6,845	66
Total volume	M.ft.B.M. 426,000		M.ft.B.M. 251,000		M.ft.B.M. 74,000		M.ft.B.M. 760,000	

Note: The cut on the mixed hardwood type has been adjusted to more closely agree with the present market demands. The other types are given directly as the field study indicated as to cut and leave volumes. The allowable cut for all types is based on the field findings without adjustment.

5. BRUSH DISPOSAL AND SNAG REMOVAL:

Slash in selectively cut stands is not a serious or difficult problem. The volume of slash is reduced roughly one-fifth by a 66 per cent volume cut. The area retains a shade throwing canopy after cutting, which presents drying out and encourages decay. Special areas require slash disposal both from the fire hazard and scenic standpoints. The requirements in this disposal are taken from "Lumber Code Authority Bulletin" No. 63, dated October 31, 1934.

"1. Forest Protection during and immediately following logging:

Fire protection during and immediately following logging is an indispensable condition for forest regrowth. Responsibility for control of fires during or immediately following logging, and in any way caused by said operations, rests upon the individual operator. To insure adequate fire protection and redemption of this responsibility, the following provisions will be required:

(1) Slash Disposal.

Any person engaged in cutting forest products shall dispose of all slash up to four (4) inches in diameter resulting from such cutting operations within fifty (50) feet of the edge of the right-of-way of any main public highway or common carrier railroad, and within twenty-five (25) feet of the center line of any secondary road and any main branch or main line logging railroad, except where branch lines will be operated only during the winter months. Slash disposal is also required within four (4) rods of the line of an adjacent owner where the adjoining land bears forest growth of commercial species. Slash shall be either lopped, burned or removed. All dead snags or stubs more than fifteen (15) feet high shall be felled within such strips, and in addition, all dead hemlock and birch snags not exceeding an average of four (4) per acre for the logging area shall be felled. Near any school house, or near the buildings of any small community, or any settler, all hardwood slash within twenty (20) rods, and all coniferous slash within forty (40) rods, shall be disposed of. The disposal of slash and felling of snags and stubs shall be done concurrently with the cutting operation, or within a reasonable period thereafter not exceeding two (2) months for snag and stub felling, and not exceeding one (1) year for slash disposal."

6. THE LOGGING JOB AND THE TIMBER STAND:

One-third of the working circle lies within the Porcupine Mountains, an area where snow ranges from four to eight feet deep during the months of December to March. This snow belt is also rugged with variations in elevation from lake level to 2,000 feet. The soils are heavy, and in wet seasons woods roads require graveling to hold up under ordinary hauling. Selective cutting is not well adapted to railroad logging beyond the possibility of a main line to which the logs should be truck hauled. These factors have an important bearing on the felling, skidding, and hauling jobs; and considered from these and other numerous angles,

it seems that the operation should be conducted on a truck-haul basis, at least to the main logging railroad through the working circle. Spurs from the main logging railroad are not generally warranted under the reduced cut of selective logging, nor are they altogether feasible in the mountainous north third of the area. Sled and tractor haul to the railroad are practicable, but it is believed that company will prefer the use of logging trucks, which are recommended.

Deep snows increase the costs of logging. Skidding, log making, and swamping are most costly during the late winter months. While the ideal logging organization is one operating continuously throughout the year, in this working circle the ideal cannot be fully attained. The bulk of the logging, including transportation of the logs by truck to the main logging railroad, should be done before January 1. The peak period of woods work will be from late fall to January 1. On a reduced scale marking, felling, bucking, skidding and some hauling may be carried on economically any time other than January 1 to May 1. The selective-cut element alone encourages this continuous operation, since spur roads and other transportation improvements may be built up for permanent use in future cutting cycles. Only a few minor improvements will be abandoned after the first cut in a selective operation.

Felling, whether done in winter or summer, is of importance second to marking in the successful accomplishment of selective continuous cut logging. Rigid supervision must be given to the cutters to insure care in dropping the trees. The maximum cut can only be made under assurance of minimum damage to the residual stand. The logging boss, firmly convinced of the desirability of leaving the maximum of unbroken young trees on the cut-over area, will have little trouble selling the idea to the cutters, but one without this belief has failed before the job begins. Every thrifty young tree is valuable, regardless of its diameter. An all-aged forest must be retained, if continuous production is to be secured. It is not difficult to teach the cutter to respect the unmerchantable tree, if the supervising agent is sold on the idea. This thought has been proven innumerable times on United States Forest Service timber sales throughout the United States.

7. SILVICULTURAL STUDIES:

Considerable information is available as to the proper silvicultural method to be used in an all-aged selection forest such as occurs within this working circle. The character of defect,

diameter limits above which cull is likely to be present, and general thrift of the tree, as determined from the appearance of the crown, are pretty well known and understood. There is, however, a need for information concerning the growth in a selectively cut stand in this particular area.

A study recommended for this working circle along this line is briefly described as follows:

Establish on the first year's selective cut two, four-acre plots, 20 chains long and two chains wide, on each of the three major types - mixed hardwoods, hardwood-hemlock, and hemlock. Measure each tree left after cutting, as to diameter breast high and number of merchantable logs. Mark the plot permanently on the ground, and show its location on a map. Make follow-up measurements at five-year intervals to determine the increased growth rate in board feet per acre per year after selective cutting. Compare with the 180 board feet per acre per year set up in the original management plan and if differences appear, changes in the allowable cut and cutting cycle may be made.

A sample planting job on a small scale is suggested. Several thousand acres of the area are stocked to aspen saplings. A small part of this area will not restock to more valuable hardwoods in less than 100 years. An experimental planting of 20 to 40 acres to white spruce, white oak, and white pine is considered worth while. If these species can be raised successfully, subsequent fire areas may be planted to bring them into immediate productivity, rather than to have them restock naturally to a more inferior species.

On an area of 40 or more acres, a group selection cutting system might be given trial. This silvicultural system would tend to destroy the even canopy idea, the residual commercial trees being left in groups instead of as single trees. The theoretical advantage of such a plan is to increase the percentage of the more light demanding trees coming into the stand. These trees include basswood, elm, and the birches. No change in volume cut from the average acre will occur under an experiment of this nature.

8. REGULATION OF THE CUT:

The rotation is placed at 200 years. Trees held in the stand beyond this age, which is beyond maturity, are held at a risk.

Eight cutting cycles of 25 years each have been adopted for each rotation. The volume possible of removal in each cutting cycle is sufficient to make an economic operation, and to supply the demands of the market.

Data on growth in selectively cut stands, from which the cutting cycle was determined, is taken from stands outside of the Fisher Body working circle. Further studies must be made within the area to check the cutting cycle recommended.

9. ALLOWABLE CUT:

The cut recommended in the first cutting cycle is based on the removal of those trees which are causing an annual loss in increment in the virgin stands, plus sufficient additional trees in the larger diameter classes to make the operation economic and profitable. The total allowable cut is 760 million feet, board measure, in the first 25 years, or an amount approximating 30,400,000 feet per year. The total cut for the 25-year period must not be exceeded if continuous production is to be attained. Only closer utilization as of mine timbers, chemical wood, or small dimension stock permits a cut in excess of the total amount set up. The annual cut may fluctuate, if necessary, to keep in step with the market. In other words, continuous production is desired, though not necessarily a production sustained at the same volume cut annually, or even within each cutting cycle.

10. THE CUTTING AREA:

The allowable first cut will be made on an area of 111,150 acres, or roughly 4,450 acres per year. The stand is 89 per cent virgin timber, and it does not appear essential to direct the cut toward any particular block to remove the worst timber first. Extended areas of timber poorer than average do not occur, and neither are the more thrifty stands, which might be logged last, blocked out on large areas. It seems, therefore, entirely permissible to direct the order of cutting in accordance with expected demands for certain species during the first cutting cycles. Since there is little question that maple, birch, and hardwood lumber is desired over softwoods, and these species are predominant in the Porcupine Mountain region, the general direction of the cut will be from the approximate north center of the General Motor Company holdings in the vicinity of Little Carp Lake, west and south in a counter clock-wise direction through the working circle, returning to a point of beginning, in 1960. It should be realized that any large breaks in a logical cutting

procedure in the first cut, will cause a similar disruption in future cutting cycles. In theory, the ideal cutting procedure would be to cut adjoining 4,450 acre blocks annually for 25 years, at the end of which time the process could be repeated on the second cut. This ideal is more nearly approached by the operator, who holds it constantly before him.

In practice these annual cutting blocks can be delineated from the detailed estimates, and the exact volume to be removed in each determined in advance of initiating continuous cutting procedure. Those blocks heaviest to the least desired species - such as hemlock - may then be cut latest.insofar as it is possible to do this without leaving uncut blocks stranded and subject to costly logging later on. While unusual demands for certain species or sizes may be met by slight shifts in cutting progression, such demands should never be supplied by excessive cutting on any particular type or smaller unit of area. Clean cut forties within the working circle must not occur. Conversely, trees not desired at the moment may be left on a cutting area when over the flexible diameter limits, but only with advance knowledge that heavy loss will be concentrated in them before they are removed in the next cutting cycle, and that a follow-up logging within the present cutting cycle when the demand for the species is sufficient, will increase the logging costs a great deal. .

The cutting direction set up has as one of its objectives the least possible main line logging road haul through cut-over areas. This is a fire hazard reduction measure of great importance. Shaded rights of way involve the least fire hazard.

Annually posted cutting progress maps are necessary to show the areas cut over and the degree of compliance with the original cutting procedure set up. From these maps the cutting order will be guided in the next cutting cycle.

11. CUTTING BUDGET:

A cutting budget commonly indicates the volume of timber to be removed by years or periods of years within one cutting cycle, from a portion of the total acreage to be cut over in the cutting cycle. This area should be delineated on the ground. A cutting budget may also show the approximate expected volumes to be cut in each cutting cycle of the rotation.

Estimates used in this report are not sufficiently detailed to apply to tracts representing a cut for one year, or any period of years less than half the total cutting cycle period of 25 years.

No annual or periodic cut has, therefore, been allotted to any definite area on the ground. From this report it is possible only to state that in the first cutting cycle an annual volume of 30,400,000 feet, board measure, may be cut from an approximate area of 4,450 acres. The second cutting cycle will remove annually 23,600,000 feet, board measure, on roughly 4,450 acres. This second cut is lighter than the first because of the heavy salvage necessary on the first 25 years of operation in decadent stands of virgin timber. Closer utilization during the period 1960 to 1985 will doubtless increase the volume of cut over this 23½ million feet, board measure, and further increase is possible through an expected higher growth rate on the improved stand through improvement in the quality after the first cut. Our growth allowance does not include that growth occurring on trees under 10 inches in diameter, which will grow into commercial sizes. It includes only the prediction for the commercial size trees left after the first cut is completed. Volumes possible of cut in the future will also increase with the addition of 11,204 acres now cut or burned over, but which will come into production in the first rotation. Due to these various factors, it is conservatively calculated that in the fifth cutting cycle the cut will again equal that made in the first cut, and the approach to that point will be on a constantly ascending scale.

During the rotation of 200 years under the selection cutting plan, 5½ billion feet, board measure, in saw-log timber alone will be cut and at the end of that time 370 million feet, board measure, will be left for future cuts. At the same time, clear cutting would produce only 1-3/4 billion feet, if fire did not destroy a portion of the highly hazardous clear-cut area during the period.

Total Production Selective-Cutting Method

	M feet board measure
Cut during 200 year period	5,500,000
Residual stand at end of 200 year period	370,000
TOTAL	5,870,000

Total Production Clear-Cutting Method

Cut during 200 year period	1,161,000
Volume on ground at the end of 200 year period	580,000
TOTAL	1,741,000

A P P E N D I X

CONTINUOUS OPERATION POSSIBILITIES ON FISHER BODY LANDS WITHIN THE FISHER BODY WORKING CIRCLE.

The General Motors Corporation owns 35,132 acres within the 125,000 acre working circle. Its estimates show an average of 8,000 feet, board measure, per acre, or a total volume of 281,358 M feet, board measure. Using these figures, and removing 66 per cent of the volume, the allowable annual cut on company lands alone would be slightly more than 6 million feet, board measure, per year. In 30 years the cut could be repeated at an approximate equal rate. This 30 year period represents the cutting cycle.

The company cuts on an average 20 million feet, board measure, per year. At this rate under selective cutting the stand would be cut in ten years, causing a complete shut-down of mill and woods operations for a period of 20 years. This hiatus may be averted by the purchase of additional timber within the working circle.

A comparison of selective and clear-cut logging within the Fisher Body working circle, for company land alone, shows the following:

Total Production Selective-Cutting Method

	M feet board measure
Total cut during 200 year period	1,200,000
Residual stand at end of 200 year period	100,000
TOTAL	1,300,000

Total Production Clear-Cutting Method

Total cut during 200 year period	281,000
Volume on ground at end of 200 year period	140,500
TOTAL	421,500

Selective logging will produce more than three times the volume on the same area in one rotation as it is possible to secure by clear cutting on 35,132 acres of company land within the Fisher Body working circle.

RELATION OF GENERAL MOTORS CORPORATION ESTIMATES AND THE FOREST SERVICE RE-ESTIMATES FOR THIS PROJECT ON THE 125,000 ACRE WORKING CIRCLE.

A compilation of estimates submitted for use in this report by the General Motors Corporation shows 1,300 board feet per acre less than the estimate made for the area as a preliminary to this report. The company estimates were made between the years 1920 to 1934 and the timber was purchased in 1927.

The difference in the two estimates results in certain conclusions:

1. The average volume per acre over the entire working circle is higher than that on the company lands alone within the working circle.

2. Our current estimates include 600 feet, board measure, per acre in a class of material not estimated in feet, board measure, by the General Motors Corporation. The actual difference between the two estimates, reduced to the same standards, is only 700 board feet.

3. Since our per cent of cut is based on an estimate higher than that normally occurring under the cruising method of the company, it also follows that the allowable cut for each species will be slightly higher than shown on the various stand tables.

THE STAND TABLES

The stand tables show the number of trees by diameter classes, separately by species, on the average acre of timber land. They represent composite pictures of the timber stand. Theoretically, if the virgin area were stripped of all trees and a careful record kept of each tree by diameter class and species, and each group of diameter classes and species were divided by the total acreage cut over, the resultant averages could be placed in a table form which would duplicate in every detail that of table 1-A.

All stand tables in this report, whether for the stand to be cut or left, show the total number of trees under the 11-inch diameter class. These trees are not actually to be cut as might be supposed from tables 3-A, 6-A and 8-A.

Stand tables are built by measuring the trees on sample areas and reducing the total number to an acre basis. Estimates of timber are ordinarily not satisfactory for use in stand table construction. In this project 427, fifth-acre plots were measured at 20-chain intervals on the strips shown on the type map. A total of 6010 trees were measured as to diameter on 85.4 acres to obtain the stand tables. The trees in the three to nine-inch diameter classes were measured on an equal number of fortieth-acre plots. Stand tables do not show the distribution of trees for any particular acre, forty or township, but they do show the distribution on the average acre over the entire area of timber types.

A stand table is the first essential in the management of the northern hardwood forest. It indicates the arrangement of the diameter classes. The true selection forest is one which shows a constant decrease in number of trees from the smallest diameter to the largest. This condition is illustrated almost perfectly by the sugar maple in stand table 1-A. A forest exhibiting this arrangement of diameters is perfectly suited to selective logging.

A stand table shows the percentage of total trees represented by each species. This is important not only from the lumber value standpoint, but it indicates the possibility of adjusting the allowable cut to fill economic demands for certain species.

Stand tables are a means of determining the approximate flexible diameter cutting limit. When stand tables are built for the stand to be cut, as well as that left, both may be used for innumerable worth-while calculations as was done in this report.

EXPLANATION OF STAND TABLE 6-A

Company timber differs only slightly from that on the entire working circle within which it is contained. The similarity of the volumes by species is shown in the summary on page 3 under "Species Composing Present Volume." From this it is apparent that the stand table for the average virgin stand on the entire working circle applies sufficiently well for the company lands alone, and if the volumes to be cut are guided by this stand table no error will result.

However, for practical and economic reasons, it may seem desirable to reduce the cut of the more inferior species, such as hemlock and elm, and increase the percentage of sugar maple logged. Table No. 6-A has been developed to fit this need and cutting on the mixed hardwood type may be guided by the revised table, without changing the set-up for the entire area.

This adjustment should be understood to represent only a makeshift one, without the firm foundation behind the Stand Table No. 1-A for all virgin types. It merely indicates the best way to increase the cut of the species at present most desired.

An adjustment of this character will increase the cut of the least desired species, hemlock and elm, in the next cutting cycle and reduce the per cent of sugar maple.

TABLE No. 11-A

VOLUME TABLE

Net volumes of trees on the Fisher Body Working Circle

Diam. breast high	Sugar maple	Hem-lock	Yellow birch	Bass-wood	Red maple	Cedar	White spruce	Balsam	Black &white ash	Elm	White pine	Red oak
10	5	13	0	0	0	10	18	20	0	0	25	0
11	11	25	10	10	8	18	34	29	9	10	39	10
12	20	40	20	22	12	25	55	46	25	22	57	27
13	40	49	40	50	29	30	78	72	41	34	76	42
14	60	75	51	70	48	36	100	109	63	46	93	54
15	82	104	68	82	67	50	131	133	90	64	140	69
16	111	140	86	97	88	80	171	160	112	90	184	85
17	149	176	105	120	108	104	220	190	135	126	237	111
18	185	200	128	154	121	118	283	206	158	158	284	165
19	219	225	150	198	128	130	351		182	185	332	220
20	248	245	181	242	130	146	419		208	210	388	280
21	283	265	219	280	132	168	492		238	242	434	316
22	312	294	254	322		185	570		268	277	488	340
23	352	331	282	359		208	660		300	308	540	360
24	395	382	318	407		230	742		350	343	598	365
25	446	478	355	478		258			400	375	658	375
26	492	530	390	560		284				404	716	380
27	549	574	418	660		315				436	780	395
28	600	605	450	760						460	847	406
29	649	656	489	840						493	920	422
30	702	708	538	900						520	1030	445
31	752	763	592							545		470
32	808	840	651							569		497
33	870	928	718							588		522
34		1000								605		555
35		1048								625		580
36		1090								642		
No. of trees basis	564	240	161	54	42	40	38	35	36	34	17	15

Compiled from estimates of standing trees, by form class. Table to be used only on area of project. Hardwoods taken to a 10-inch variable top; conifers to an 8-inch variable top. Most reliable data above black double line. (3/6/35). Volumes above dotted line are for trees with less than a 10-foot log to a 10-inch top.

TABLE No. 12-A

LOGGING COST COMPARISON FOR CLEAR CUT vs. SELECTIVE CUT
REMOVING 66 PER CENT BY VOLUME OF ALL SPECIES

Diameter, breast high	Board Feet per acre, clear cut	Costs per M ($8.10 log run)	Costs per acre, clear cut	Board Feet per acre, selective cut	Costs per acre, selective cut
11	182	$11.79	$ 2.14	13	$ .15
13	664	10.50	6.97	77	.81
15	1,089	9.47	10.59	243	2.30
17	1,506	8.62	12.96	540	4.65
19	1,542	8.02	12.39	940	7.53
21	1,263	7.60	9.61	1,062	8.06
23	1,062	7.26	7.72	997	7.24
25	1,034	7.06	7.32	996	7.04
27	593	6.92	4.10	573	3.96
29	504	6.78	3.42	486	3.30
31	296	6.67	1.97	296	1.97
33	218	6.57	1.43	218	1.43
35	174	6.54	1.14	174	1.14
37	12	6.44	.77	12	.77
39	73	6.41	.47	73	.47
41	30	6.36	.19	30	.19
43	38	6.29	.24	38	.24
45	21	6.27	.13	21	.13
47	0	0	0	0	0
49	25	6.20	.15	25	.15
51	0	0	0	0	0
53	30	6.17	.18	30	.18
TOTAL	10,356	$ 8.10°	$83.89	6,844	$51.71

°The $8.10 log run cost includes an allowance for mill over-run.

TABLE No. 12-B

MILLING COST COMPARISON FOR CLEAR CUT vs. SELECTIVE CUT
REMOVING 66 PER CENT BY VOLUME OF ALL SPECIES

Diameter, breast high	Board Feet per acre, clear cut	Costs per M ($9.70 mill run)	Costs per acre, clear cut	Board Feet per acre, selective cut	Costs per acre, selective cut
11	182	$11.60	$ 2.12	13	$ .15
13	664	11.10	7.36	77	.86
15	1,089	10.58	11.50	243	2.57
17	1,506	10.19	15.30	540	6.43
19	1,542	9.85	15.20	940	9.26
21	1,263	9.64	12.18	1,062	10.23
23	1,062	9.39	9.97	997	9.36
25 and over	3,048	8.90	27.12	2,972	26.21
TOTAL	10,356	$ 9.70°	$100.75	6,844	$65.07

°The $9.70 mill run cost includes an allowance for mill over-run

TABLE NO. 12-C

VOLUME AND VALUE COMPARISON FOR CLEAR CUT VS. SELECTIVE CUT
REMOVING 66 PER CENT, BY VOLUME, OF ALL SPECIES

Diameter, breast high	Volume per acre				Lumber value, based on current prices				Total volume B. M.	Total Lumber Value B. M.
	Sugar maple	Yellow birch	Hemlock	Other	Sugar maple	Yellow birch	Hemlock	Other		
CLEAR CUT - (STAND TABLE I-A)										
11			115	67			2.49	1.48	182	3.97
13	251	68	170	175	6.15	1.66	3.68	4.20	664	15.69
15	465	88	286	250	14.06	2.35	6.18	6.62	1089	29.21
17	690	145	357	314	20.23	4.16	7.70	9.07	1506	41.16
19	722	193	328	299	22.85	5.93	7.08	9.30	1542	45.16
21	594	186	268	215	20.13	6.03	5.80	7.14	1263	39.10
23	462	130	272	198	16.69	4.56	5.91	6.99	1062	34.15
25 & over	640	409	1212	787	24.65	15.69	26.31	29.48	3048	96.13
TOTAL	3824	1219	3008	2305	124.76	40.38	65.15	74.28	10356	304.57
								VALUE PER M		$ 29.41
SELECTIVE CUT - (STAND TABLE 3-A)										
11			10	3			.21	.06	13	.27
13	15	5	15	42	.36	.13	.33	1.05	77	1.87
15	67	21	40	115	1.78	.53	.85	3.07	243	6.23
17	201	57	112	170	5.87	1.62	2.42	4.91	540	14.82
19	382	158	155	245	12.04	4.80	3.34	7.60	940	27.78
21	469	184	228	181	16.04	6.00	4.94	6.02	1062	33.00
23	423	130	255	189	15.29	4.56	5.53	6.66	997	32.04
25 & over	627	405	1198	742	24.02	15.64	26.00	27.79	2972	93.45
TOTAL	2184	960	2013	1687	75.40	33.28	43.62	57.16	6844	209.46
Per cent of volume cut	57	79	67	73					66	
Per cent of value cut	60	82	67	77					69	
								VALUE PER M		$ 30.60

Seventy five per cent of the value of all but sugar maple is recommended for cut. This represents only 71 per cent of the volume.

TABLE NO. 12-D

VOLUME AND VALUE OF LUMBER GRADES ON THE AVERAGE ACRE OF VIRGIN TIMBER
FISHER BODY WORKING CIRCLE

SUGAR MAPLE - CLEAR CUT

Diameter, breast high	Volume on average acre	F.A.S.		Select		No. 1 common		No. 2 common		No. 3 common		Total
		Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Value
11												
13	251	4	0.29	7	0.44	34	1.73	40	1.20	166	2.49	6.15
15	465	15	1.08	17	1.07	75	3.83	75	3.83	283	4.25	14.06
17	690	35	2.52	32	2.02	130	6.63	111	3.33	382	5.73	20.23
19	722	48	3.45	40	2.52	157	8.01	114	3.42	363	5.45	22.85
21	594	49	3.52	39	2.46	144	7.34	92	2.76	270	4.05	20.13
23	462	46	3.31	35	2.20	123	6.27	69	2.07	189	2.84	16.69
25 & over	640	76	5.47	55	3.47	184	9.38	90	2.70	235	3.63	24.65
TOTAL	3824	273	19.64	225	14.18	847	43.19	591	19.31	1888	28.44	124.76

SUGAR MAPLE - SELECTIVE CUT

11												
13	15	.2	.01	.4	.03	2.1	.11	2	.06	10.3	.15	.36
15	67	2.	.14	2.	.13	11.	.56	11	.33	41.	.62	1.78
17	201	10.	.72	9.	.57	38.	1.94	32	.96	112.	1.68	5.87
19	382	25.	1.80	21.	1.32	83.	4.23	60	1.80	193.	2.89	12.04
21	469	39.	2.80	31.	1.95	114.	5.81	73	2.19	212.	3.29	16.04
23	423	42.	3.02	32.	2.02	113.	5.76	63	1.89	173.	2.60	15.29
25 & over	627	74.	5.33	54.	3.40	180.	9.18	88	2.64	231.	3.47	24.02
TOTAL	2184	192.2	13.82	149.4	9.42	541.1	27.59	329	9.87	972.3	14.70	75.40

VALUE PER M BY GRADES

F.A.S.	$72.00
Select	63.00
No. 1 common	51.00
No. 2 common	30.00
No. 3 common	15.00

Per cent of volume in each grade taken from Page 22 of Technical Bulletin 164 "Selective Logging in Hardwoods, Lake States."

TABLE NO. 12-E

VOLUME AND VALUE OF LUMBER GRADES ON THE AVERAGE ACRE OF VIRGIN TIMBER
FISHER BODY WORKING CIRCLE

Diameter breast high	Volume on average acre	F.A.S. Volume	F.A.S. Value	Select Volume	Select Value	No. 1 common Volume	No. 1 common Value	No. 2 common Volume	No. 2 common Value	No. 3 common Volume	No. 3 common Value	Total Value
YELLOW BIRCH - CLEAR CUT												
11												
13	68	3	.25	2	.13	10	.41	12	.30	41	.57	1.66
15	88	5	.41	4	.25	15	.62	15	.38	49	.69	2.35
17	145	11	.90	8	.50	27	1.11	24	.60	75	1.05	4.16
19	193	18	1.48	12	.76	39	1.60	32	.80	92	1.29	5.93
21	186	20	1.64	13	.82	40	1.64	31	.78	82	1.15	6.03
23	130	17	1.39	11	.69	30	1.23	22	.55	50	.70	4.56
25	409	66	5.41	39	2.46	104	4.26	69	1.73	131	1.83	15.69
TOTAL	1219	140	11.48	89	5.61	265	10.87	205	5.14	520	7.28	40.38
YELLOW BIRCH - SELECTIVE CUT												
11												
13	5	0	.01	0	.01	1	.04	1	.03	3	.04	.13
15	21	1	.08	1	.06	3	.12	4	.10	12	.17	.53
17	57	4	.33	3	.19	11	.45	9	.23	30	.42	1.62
19	158	14	1.15	10	.63	32	1.31	26	.65	76	1.06	4.80
21	184	20	1.64	13	.82	40	1.64	31	.78	80	1.12	6.00
23	130	17	1.39	11	.69	30	1.23	22	.55	50	.70	4.56
25	405	67	5.49	39	2.46	102	4.18	68	1.70	129	1.81	15.64
TOTAL	960	123	10.09	77	4.86	219	8.97	161	4.04	380	5.32	33.28

VALUE PER M BY GRADES

F.A.S.	$ 82.00
SELECT	63.00
NO. 1 COMMON	41.00
NO. 2 COMMON	25.00
NO. 3 COMMON	14.00

Per cent of volume in each grade taken from Page 22 of Technical Bulletin 164 "Selective Logging in Hardwoods, Lake States."

TABLE NO. 12 F

VOLUME AND VALUE OF LUMBER GRADES ON THE AVERAGE ACRE OF VIRGIN TIMBER
FISHER BODY WORKING CIRCLE

Diameter breast high	Volume On average acre	HEMLOCK - CLEAR CUT Merchantable Volume	Merchantable Value	No. 3 common Volume	No. 3 common Value	No. 4 common Volume	No. 4 common Value	Total Value
11	115	70	1.75.	40	.68	5	.06	2.49
13	170	104	2.60	58	.99	8	.09	3.68
15	286	175	4,38	95	1.62	16	.18	6.18
17	357	220	5.50	116	1.97	21	.23	7.70
19	328	203	5.08	104	1.77	21	.23	7.08
21	268	168	4.20	83	1.41	17	.19	5.80
23	272	173	4.33	81	1.38	18	.20	5.91
25	1212	776	19.40	351	5.97	85	.94	26.31
TOTAL	3008	1889	47.24	928	15.79	191	2.12	65.15
		HEMLOCK - SELECTIVE CUT						
11	10	6	.15	3	.05	1	.01	.21
13	15	9	.23	5	.09	1	.01	.33
15	40	24	.60	13	.22	3	.03	.85
17	112	69	1.73	36	.61	7	.08	2.42
19	155	96	2.40	49	.83	10	.11	3.34
21	228	143	3.58	70	1.19	15	.17	4.94
23	255	162	4.05	76	1.29	17	.19	5.53
25	1198	767	19.18	347	5.90	84	.92	26.00
TOTAL	2013	1276	31.92	599	10.18	138	1.52	43.62

VALUE PER M BY GRADES

MERCHANTABLE	$25.00
NO. 3 COMMON	$17.00
NO. 4 COMMON.	$11.00

Per Cent of volume in each grade taken from page 22 of Technical Bulletin 164 "Selective Logging in Hardwoods, Lake States".

TABLE NO. 12-G

VOLUME AND VALUE OF LUMBER GRADES ON THE AVERAGE ACRE OF VIRGIN TIMBER
FISHER BODY WORKING CIRCLE

Diameter breast high	Volume on average acre	F.A.S.		Select		No. 1 common		No. 2 common		No. 3 common		Total
		Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Value
OTHER SPECIES - CLEAR CUT												
11	67		.02	1	.08	7	.37	10	.28	49	.73	1.48
13	175	2	.14	5	.31	24	1.20	28	.81	116	1.74	4.20
15	250	8	.56	9	.55	41	2.05	41	1.19	151	2.27	6.62
17	314	16	1.12	15	.92	59	2.95	51	1.48	173	2.60	9.07
19	299	20	1.40	17	1.04	65	3.25	47	1.36	150	2.25	9.30
21	215	18	1.26	14	.85	52	2.60	33	.96	98	1.47	7.14
23	198	19	1.33	15	.92	53	2.65	30	.87	81	1.22	6.99
25	787	93	6.51	68	4.15	225	11.25	111	3.22	290	4.35	29.48
TOTALS	2305	176	12.34	144	8.82	526	26.32	351	10.17	1108	16.63	74.28
OTHER SPECIES - SELECTIVE CUT												
11	3						.02		.01	2	.03	.06
13	42	1	.07	1	.06	6	.30	7	.20	28	.42	1.05
15	115	4	.28	4	.24	19	.95	19	.55	70	1.05	3.07
17	170	9	.63	8	.49	32	1.60	27	.78	94	1.41	4.91
19	245	16	1.12	14	.85	53	2.65	39	1.13	123	1.85	7.60
21	181	15	1.05	12	.73	44	2.20	28	.81	82	1.23	6.02
23	189	19	1.33	14	.85	50	2.50	28	.81	78	1.17	6.66
25	742	87	6.09	64	3.90	213	10.65	105	3.05	273	4.10	27.79
TOTALS	1687	151	10.57	117	7.12	417	20.87	253	7.34	750	11.26	57.16

VALUE PER M BY GRADES

F.A.S.	$ 70.00
SELECT	61.00
NO. 1 COMMON	50.00
NO. 2 COMMON	29.00
NO. 3 COMMON	15.00

Per cent of volume in each grade taken from Page 22 of Technical Bulletin 164, "Selective Logging in Hardwoods, Lake States."

(Missing)

Table No. 13-A
STOCK AND STAND TABLE -PROPOSED
CUT - MIXED HARDWOOD TYPE

( )

TABLE NO. 14A

AVERAGE VOLUME OF TREES IN FIRST CUTTING CYCLE
ALL VIRGIN TYPES - 75.4 ACRES OF SAMPLE

	Total Stand Board Measure	Stand to be Cut Board Measure	Stand Left Board Measure
Sugar maple	120	259	70
Hemlock	167	341	82
Yellow birch	127	224	49
Basswood	174	272	60
Red maple	54	106	38
Cedar	63	94	29
White spruce	108	242	74
Balsam	53	84	28
Black and white ash	83	196	26
Elm	124	260	17
White Pine	730	1179	32
Red Oak	256	343	73

TABLE NO. 14-B

CULL TREES BY SPECIES FOR ALL TYPES

(Ten inches and over diameter classes)

Species	*Percentage of Cull trees in stand	Average Diameter of cull trees, in inches	Volume board measure of Average cull tree
Red maple	38 %	14.1	48
Yellow birch	23	18.1	128
Red oak	21	22.3	340
Black and white ash	16	13.4	41
Elm	10½	19.6	210
Sugar maple	10	14.9	82
Basswood	8½	21.3	280
Hemlock	7	18.5	210
Balsam	5½	11.0	29
Cedar	5	22.0	185
White Pine	-	-	-
White spruce	-	-	-

*Cull trees include only those with at present less than 10 feet of merchantable length to a ten-inch top in hardwoods, and an 8-inch top in conifers, and those which will not grow into commercial sizes because of crook, etc.

Data for red oak, white pine, elm, balsam, and the ashes not reliable. The trend only is indicated in the above table.

TABLE NO. 14-C

CULL TREES PER ACRE ON MAJOR TYPES
(All species)

(Ten inches and over diameter classes)

Type	Number of culls per acre	Average diameter, in inches	Gross Volume of cull per acre
Mixed hardwoods	5.3	18.0	1,110
Mixed hardwood and hemlock	7.9	16.1	1,110
Pure hemlock	8.6	16.4	1,330
Weighted average	6.2	17.3	1,190

TABLE No. 15-A

DETAILED LAND OWNERSHIP IN FISHER BODY WORKING CIRCLE

Owner			Number of Acres
Keweenaw Lands			38,141.80
General Motors	Fee	8,989.39	
	Surface	12,169.25	
	Timber	13,973.36	35,132.00
Longyear Estate			11,513.49
R. Connor Company			6,557.15
S. Coleman			5,505.07
Porcupine Land Association			4,060.94
Bonifas Lumber Company			2,880.00
Copper Range Company			2,104.48
R. R. Snow			1,968.36
Garvin Estate			1,731.01
Dollar Savings and Trust			1,413.05
Wade Estate			1,381.20
E. Hough			1,380.30
J. Hawley			840.00
Greenwood Lumber Company			760.00
H. L. Camp			640.00
C. and N. W. Land Company			566.60
Jones Estate			558.55
C. Strody			520.00
M. Sells			421.52
Sage Land and Improvement Company			400.00
E. O. Stafford			360.00
G. A. Berglund			350.31
S. Case			320.00
Diamond Match Company			268.57
A. Prescott			200.00
L. Herbert			200.00
State			237.60
Philadelphia Trust Company			160.00
T. L. and T. Company			139.80
H. Johnson			151.25
W. G. Mather			160.00
S. M. Young			154.80
C. Kaufman			120.90
R. T. Looney			120.40
Healey and Territt			117.60
Alexander Timber Company			160.00
J. Anderson			160.00
R. E. Anderson			130.20

Owner	Number of Acres
McRae	80.00
Worcester Lumber Company	80.00
J. Pinton	30.14
J. Person	31.56
J. Amundson	31.88
N. Hanson	72.19
C. F. Riedmeyer	80.00
M. O. Robinson	80.00
C. Beyer	40.00
J. Pete	40.00
E. Jones Land Company	80.00
E. J. H.	40.00
Pryor Estate	40.02
C. H. Taylor	40.00
Mrs. M. Gill	80.00
J. G. Martin	46.50
E. Anderson	80.00
C. S. Cook	40.00
Rust Estate	40.00
W. H. Garlick	63.40
M. G. Blake	48.00
Unknown	2,023.71
Miscellaneous	189.00
TOTAL	125,000 Acres

DETAILS OF THE MARKING JOB:

In addition to the need for varying the marking by timber types, each acre; each group of trees must be considered separately. Swamp hardwoods require different treatment from highland hardwoods Yellow birch may be practically worthless on upper levels, whereas on lower slopes it reaches its optimum development and growth. White spruce is liable to wind throw and must be cut when extending well above the general crown level, or when on exposed places. The less valuable red maple and hemlock should be cut heavily to reduce their volume in future cuts if the present demand makes this possible. Balsam is a short-lived tree and must be cut out at small diameters. White pine trees of fairly large diameter should be retained for seeding purposes. Elm continues a rapid growth rate into an older age than other species, and lives longer. It, therefore, has a higher flexible diameter cutting limit. The maples are brittle and need more protection in the tops from wind than the other constituents of the hardwood type. Older and larger hemlock, if left in the residual stand, frequently die before the next cut. Young, smaller hemlocks do not die, but show great response to release.

Sample Marking.

It is desirable on this working circle that United States Forest Service mark sample areas of from 10 to 20 acres in each major timber type. These tracts, permanently marked on the ground, may be cut over either completely or in part and retained as demonstration areas for the guidance of the woods supervision and the company timber markers. Sample marking should be done on areas typical of conditions on the working circle and a record made of the trees cut and left, so that a stand table may be built for comparison with Tables 5-A, 6-A, 7-A, 8-A, 9-A, 10-A, in this report.

Check Marking.

Marking should be checked while cutting is in progress and before the cutters have left the area, in order that errors may be corrected. Some errors in judgment as to the individual tree cut or left will always occur, and a constant check is necessary. In addition, checks to determine if the proper percentage of volume has been marked must be made covoring the work of each marker. This is generally done by making a 20-per cent "cut and leave" tally of the marked stand on a representative forty, or section.

The timber marker must gain experience in these and many other points on the job under capable supervision. Written instructions cannot fill the place of woods work. The success of selection cutting rests primarily with the timber marker. He must not destroy the residual stand to fill the present economic demand for certain species or size classes, nor by a careless selection of the trees to be cut.

Cull Trees and the Marking Job.
(See Table 14-B and 14-C, Appendix).

In this report any hardwood tree over 10 inches in diameter, breast high, is considered a cull if at present it contains less than one 10-foot log with a minimum 10-inch top, or which because of crook or sweep would not eventually grow into a commercial tree with a minimum log of these dimensions. Conifers are considered likewise, but to a minimum top diameter of eight inches. Cull in trees worth cutting, and cull trees worthless for saw logs, must be carefully considered by the timber marker who must know the external signs of cull, which differ for each species. If cull trees are to be left in the stand, and this is the common economic procedure, then they must be given due consideration in relation to trees to be cut. Large groups of undisturbed cull trees should be avoided. Openings must be made in the stand, but these openings should never be so large as to cause a drying out of the soil, resulting in increased fire hazard. Forked and leaning, fire-scarred, cankered, insect-infested, and spindle and spike-topped trees should be cut out in the first cutting period.

An average of 6.2 cull trees per acre occur on the virgin timber types on the Fisher Body working circle, and the diameter of the average cull tree is 17 inches. The highest percentage of cull trees is found in red maple, yellow birch, and red oak. Trees showing cull in diameters ranging from 14 to 15 inches include red and sugar maple, the ashes, and balsam. Under selective logging these trees will be largely utilized before becoming culls. In the present virgin stand they are an index to its condition and a problem to the timber marker, who must not be influenced to consider these culls with the residual stand required by the marking rules. Frequently, we are given the ocular impression of a light first cut, when in reality closer examination of the stand reveals 5 to 10 cull trees per acre entirely worthless to future operations.